

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

AMENDMENTS TO THE TITLE:

Please amend the title to read as follows:

--FUEL INJECTION DEVICE[,]~~IN PARTICULAR FOR AN INTERNAL~~
COMBUSTION ENGINE WITH DIRECT FUEL INJECTION, AND METHOD FOR
PRODUCING IT THE DEVICE--

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

- [0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS
[0000.4] This application is a 35 USC 371 application of PCT/DE 2004/001997
 filed on September 8, 2004.
[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0001] with the following amended paragraph:

- [0001] Prior Art **Field of the Invention**

Please replace paragraph [0002] with the following amended paragraph:

- [0002] The invention relates first to a fuel injection device, and to a method of
manufacturing the device, in particular for an internal combustion engine with direct fuel
injection, the device having a housing and at least two valve elements, located in the housing
and coaxial to one another, to each of which at least one fuel outlet opening is assigned, and
on the outer valve element, radially outward from the at least one fuel outlet opening assigned
to it, there is a first sealing region, which cooperates with a valve seat on the housing and
which can separate the at least one fuel outlet opening from a high-pressure connection.

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

Please add the following new paragraph after paragraph [0002]:

[0002.5] Description of the Prior Art

Page 2, please replace paragraph [0004] with the following amended paragraph:

[0004] The use of two valve elements, each of which is assigned at least one fuel outlet opening, allows furnishing a small or large total outlet cross section, depending on the quantity of fuel to be injected. This in turn makes it possible to inject even comparatively small fuel quantities at high injection pressure, so that in these cases, good atomization of the fuel is attained. At the same time, high fuel quantities can be injected without requiring very long injection times to do so.

Please replace paragraph [0006] with the following amended paragraph:

[0006] This object is attained[[,]] ~~in a fuel injection device of the type defined at the outset,~~ in that on the outer valve element, between the at least one fuel outlet opening assigned to it and the inner valve element, there is an additional sealing region.

Please replace paragraph [0007] with the following amended paragraph:

[0007] Advantages of the Invention

SUMMARY AND ADVANTAGES OF THE INVENTION

Please replace paragraph [0008] with the following amended paragraph:

[0008] The fuel injection device of the invention has a markedly longer service life than conventional fuel injection devices. The reason for this is that the additional sealing region largely prevents [[HC]] hydrocarbons from the combustion chamber of the internal combustion engine from penetrating the device via the fuel outlet openings associated with

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

the outer valve element and getting into the guide gap between the two valve elements, where it would cause changes in the surface properties and lead to deposits and finally to increased wear.

Page 3, please delete paragraph [0010].

Please replace paragraph [0011] with the following amended paragraph:

[0011] **Advantageous refinements of the invention are disclosed.** First, it is proposed that the additional sealing region, immediately after the manufacture of the device, with the outer valve element closed, has a slight spacing, preferably approximately 1 to 2 μm , from a valve seat associated with it. As a result, the production costs of the fuel injection device of the invention are kept low, since producing the sealing region and the valve seat associated with it does not require especially high precision. Instead, the optimal sealing action of the sealing region is achieved only in the course of the initial time in operation of the fuel injection device, namely because of the normal initial deformation or the normal initial wear at the first sealing region and at the valve seat on the housing associated with it.

Page 5, please replace paragraph [0018] with the following amended paragraph:

[0018] ~~The invention also relates to a method for producing a fuel injection device of the type defined above.~~ To keep production costs low, ~~it proposed that~~ the outer valve element is fabricated such that the additional sealing region, with the outer valve element closed, initially has a slight spacing, preferably of approximately 1 to 2 μm , from a valve seat associated with it; and that then by repeated actuation of the outer valve element, the first

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

sealing region and/or the valve seat associated with it is deformed such that the spacing between it and the valve seat associated with it becomes less or tends toward zero.

Please replace paragraph [0019] with the following amended paragraph:

[0019] ~~Drawing~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Please replace paragraph [0020] with the following amended paragraph:

[0020] Especially preferred exemplary embodiments of the present invention will be described in further detail below in conjunction with the accompanying drawings, in which: drawing. ~~In the drawing:~~

Page 6, please replace paragraph [0025] with the following amended paragraph:

[0025] ~~Description of the Exemplary Embodiments~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please replace paragraph [0026] with the following amended paragraph:

[0026] In Fig. 1, a fuel injection device is identified overall by reference numeral 10. It includes a housing 12, of which in Fig. 1 only a nozzle body 14 and a central piece 16 are shown. The nozzle body 14 is clamped relative to the central piece 16 via a ~~straining retaining screw~~, not shown.

Please replace paragraph [0027] with the following amended paragraph:

[0027] In the housing 12, there is a recess or stepped bore 18, into which an outer valve element 20 and an inner valve element 22 are inserted. Between them, there is a guide gap 23 (see Fig. 2). As will be discussed hereinafter in greater detail, a series of fuel outlet conduits

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

24 is associated with the outer valve element 20, while a series of fuel outlet conduits 26 is associated with the inner valve element 22.

Page 7, please replace paragraph [0030] with the following amended paragraph:

[0030] The inner valve element 22 also has a conical end region [[53]], with a pressure face 54 (Fig. 2) that acts in the opening direction and defines a pressure chamber 56, but the pressure chamber communicates with the high-pressure connection 40 via the annular chamber 38 and the high-pressure conduit 36 only when the outer valve element 20 is open. On the end facing away from the fuel outlet conduits 26, the inner valve element 22 also has a control face 58, which acts in the closing direction and defines a control chamber 62, which is located in the outer valve element 20 and communicates with the control chamber 44 via a conduit 60.

Page 9, please replace paragraph [0035] with the following amended paragraph:

[0035] For injecting a comparatively small quantity of fuel, the switching valve 50 is briefly opened. As a result, fuel can flow out of the control chamber 44 via the outflow throttle restriction 48 to the low-pressure connection 52. Since the fuel flows out faster than it can flow in through the inflow throttle restriction 46, the pressure in the control chamber 44 drops, as does the corresponding force acting on the control face 42 in the closing direction. As a consequence, there is a resultant force acting overall in the opening direction (after all, the high fuel pressure continues to act on the pressure faces 28 and 30), so that the outer valve

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

element 20 opens, and the sealing edges 64 and 72 lift from the opposite opposing valve seat face 66.

Page 11, please replace paragraph [0041] with the following amended paragraph:

[0041] If the additional sealing edge 72 were not present, this "leak fuel" could pass unhindered out of the pressure chamber 56 to reach the fuel outlet conduits 24 and could emerge through them into the combustion chamber of the engine. That would worsen the emissions performance of the engine. By means of the additional sealing edge 72, the communication between the pressure chamber 56 and the fuel outlet conduits 24 when the outer valve element 20 is closed is interrupted. Leak fuel passing through the guide gap [[78]] 23 can accordingly no longer reach the fuel outlet conduits 24.

Please replace paragraph [0042] with the following amended paragraph:

[0042] The additional sealing edge 72 on the outer valve element 20 has still another effect as well: In combustion, [[HC]] hydrocarbon is created in the combustion chamber of the engine. The [[HC]] hydrocarbon can reach the interior of the fuel injection device 10 via the fuel outlet conduits 24 and 26. The second sealing edge 72 reliably prevents [[HC]] hydrocarbon from getting into the guide gap 23 between the inner valve element 22 and the outer valve element 20. Correspondingly increased wear in the region of the guide gap [[78]] 23 is thus reliably avoided.

Applicant: Friedrich BOECKING
Docket No. R.305573
Preliminary Amdt.

Page 12, please replace paragraph [0045] with the following amended paragraph:

[0045] Alternative embodiments of fuel injection devices 10 are shown in Figs. 3 and 4. Elements and regions that have equivalent functions to elements and regions of the fuel injection device shown in Figs. 1 and 2 have the same reference numerals. They are not explained again in detail. The distinctions essentially pertain to the design of the conical end region 27 of the outer valve element 20 between the groove 68 and the annular protuberance 70.
70.[:]

Page 13, please add the following new paragraph after paragraph [0046]:

[0047] The foregoing relates to a preferred exemplary embodiment of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.